

REPORT ON IRRIGATION

IN THE

BUNDI STATE,

WITH

NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION
IN RAJPUTANA

COMPLIMENTARY

1904.

AJMER:
PRINTED AT THE RAJPUTANA MISSION PRESS.

1904.

INDEX

PARA.	PAGE.
1—3 Geographical Features	1
4 Rivers	1—2
5 Land Culturable and Cultivated	2
6 Population	2
7 Number of villages, Khalsa and Jaghir	3
8 Average Rainfall	3
9 Average Land Revenue	3
10 Means of Irrigation—Weirs—Tanks—Jatsagar, Naulakha, Phulsagar, Hindoli, Dugari, Nainwa, Pagara	3—4
11 Wells, Number, Cost, Depth of Water, Area Irrigated	4
12 Future possibilities of Protective Irrigation Works	4—5
13—14 Khatkar Project	5
15 Chambal Canal Project	5—6
16 Method proposed for Irrigation in Bundi... ..	6
17 Burwla Project on Tai River	6—8
18 Haripura Project on Ghora Pichar Nullah	8—9
19 Site at Moriari on Sukli River	9
20 Gudha Project on Mej River	9—10
21 Bundi-Ka-Gotra Project on Bajau River... ..	10—11
22 Pipalwasa Project on Bajau River	11—12
23 Pai Balapura Project	12
24 Small Projects	12—13
25 Neth Project	13
26—27 Sites for Tanks at Dhuora	13
28 Site for Tank at Thakro	13—14
29 Sites at Gamera and Sunidi	14
30 Nullahs on N. E. border	14
31 Sites at Khajuria, Khajuri, Bansoli, Tank at Dehi	14—15
32 Great possibilities for Irrigation in the Bundi State	15—16

IV.

Note by the Consulting Engineer for Irrigation in
Rajputana.

PARA.		PAGE
1	Remarks on the Report submitted by the Supdg Engineer	17
2	The problem of Irrigation in the Bundi State, how treated	17
3	Sites inspected by the Consulting Engineer	17—18
4	Irrigation has not been developed—loss from recent Famine—to store water is one of the best means of recovering this loss	18
5	Opinions of the Revenue Officials should be invited before carrying out Irrigation works The information now available removes many difficulties	18
6	The remarks of the Supdg Engineer in his para 21 deserve attention...	18
7	Submerged weirs recommended	18
8	Results now depend upon the Durbu	18
9	Suggest all these Projects be permanently marked	19
10	Tribute to the courtesy shown by the Durbu	19

APPENDICES.

I	Khatkai gorge	21
II	River Chambal—the Gamach Project	22
III	Bundi Storage Project	23
IV	Haripura „ „	24
V	Moriari „ „	25
VI	Pipulwara „ „	26—27
VII	Tai Bilapura	28

Index Map of Bundi State, showing sites and Catchment Areas of proposed
Irrigation Projects

REPORT ON IRRIGATION IN THE BUNDI STATE.

1. The Bundi State is bounded on the North by Jaipur and Tonk ; on the South and East by Kotah ; and on the West by Mewar. } **Geographical Features.**

2. It has an area of 2,220 square miles, the greatest length from the North East to South West corner is about 71 miles, and greatest breadth from North West to the South East corner about 47 miles.

3. The State is divided into almost 2 equal portions by a range of hills,—the Aravellis, which run from North East to South West throughout its length. In the centre of this Range, on the South side, is the city of Bundi

North of these hills, the North West portion of the State consists for the greater part of hills and rocky ground, formed of slate shale, which extend along the North border to the East into the Jaipur State ; but the remainder is all good culturable land, a large proportion being “mal” or black soil.

To the South of the Aravellis, all along the West border, there is a high rocky ridge,—a prolongation of the Sand stone ridge of Western Kotah,—which slopes from West to East, and gradually merges into a plain, stretching away to the East, of black soil on which wheat and barley are largely produced ; the land is however very broken and full of small ravines near the Rivers which flow through it.

4. CHAMBAL AND BANNAS.—The Chambal River forms the boundary between Bundi and Kotah on the South and East, and the Bannas crosses a small outlying patch of Bundi territory on the Jaipur border on the North ; but the Mej is the chief River in the State itself. **Rivers.**

MEJ RIVER.—The Mej rises in Mewar, and after flowing nearly due North for 15 miles in that State enters Northern Bundi on the West, crossing the State for 2 miles and then for another 6 forming the West boundary between Mewar and Bundi ; after which, for the rest of its course of about 95 miles, it is entirely a Bundi River.

The River flows first for 23 miles in a North East direction to Dablana, when it turns nearly due East for 15 miles to Gudha, where turning due South, after a mile it enters the Northern Range of the Aravellis, and passing through these for 6 miles, emerges on the South of the Range at the Khatkar Gorge, where the hills are only about 500 feet apart.

The River then turns in a North East direction parallel to the Aravellis, and after a winding course of about another 50 miles finally joins the left bank of the Chambal at the South East corner of the State.

BLUKEA NULLAH—On the North of the Aravellis the Mej is joined by numerous tributaries, the most important being (a) the Blukea Nullah, which rises in the hills near Satar, West of Bundi, and falls into the Right bank of the Mej after a North East course of 20 miles, at Baragaon ; (b) the

Bajaen River which joins the Left bank about 8 miles above Gudha; and (c) at this place where the Mej enters the Aravallis it is also joined by a nullah which rises in the East, near Karwan, and flowing from North East to South West, with its tributaries, drains the North East portion of the State.

BAJAEN RIVER.—The Bajaen is the chief tributary of the Mej in Northern Bundi, and rising in Mewar just beyond the North West border of the Bundi State, flows first in a North East direction for 17 miles, when it takes a turn to the South East, and after another 5 miles at Sarshod it is joined on the left bank by the Jhonpri Nullah and on the Right by the Gargani. It continues its course in a South East direction and joins the Mej 9 miles lower down, and with its tributaries it drains an Area of about 180 square miles.

SUKLI, GHORA PICHAR, AND TAI NULLAHS.—South of the Aravallis the many streams which rise in the hilly plateau on the west border of the State, flow in a North East direction and eventually form the Sukli, Ghora Pichar, and Tai Nullahs.

KURAL RIVER.—These three unite at Singhaoda, about 8 miles South East of Bundi city, and from this point the River, which is now called the Kural, continues to flow in a North East direction, twisting about for 18 miles, till it joins the Right bank of the Mej 12 miles below Khatkar.

From this point the Mej carries away practically the whole drainage of the Bundi State into the Chambal.

It is worth noting that the flow of the Rivers in both the North and South portion of the State is *towards* and not away from the central range of hills dividing the State.

Land Cultur-
able and
Cultivated.

5. Only about $\frac{1}{4}$ of the whole State is culturable the remainder being hilly and rocky.

Of the culturable land, in normal years,

	Area cultivated	Uncultivated.
	Bigha	Bigha
Khalsa . . .	4,67,000	67,000
Jaghir . . .	2,33,000	33,000
	<hr/> 7,00,000	<hr/> 100,000

Of the cultivated Area only about 1,00,000 Bighas are irrigated, the remainder producing excellent crops in normal years in the black soil, without irrigation. The average crop in "Mal" land for "wheat" and "barley" is said to be about 4 maunds per acre when unirrigated; but as much as 18 maunds is realized when irrigated.

Population.

6. The Population in 1891 was 295,675, and in 1901 only 171,227, or a loss of 42 per cent. due to the famine, and cholera and fever which followed.

(*2 $\frac{1}{2}$ Bighas make 1 Acre in Bundi.)

7. There are in all 930 villages in the State, of which 634 are Khalsa and 296 Jaghir. } Villages.

8. The average Rainfall for the last 10 years is $21\frac{1}{2}$ inches. } Average Rainfall.

9. The average land Revenue is about Rs. 5,00,000. In the Famine year it was only Rs. 2,00,000, of which $1\frac{1}{2}$ lacs were realized from Irrigated land. The revenue is paid in cash, and not in kind, and the average for unirrigated land is Rs. 2-10-0 per acre, and for irrigated Rs. 5-14-0 per acre. } Average Land Revenue.

10. WEIRS.—There are some 22 weirs built across Rivers to hold up water which is raised by “Odis” to irrigate the land on either side. } Means of Irrigation.

These weirs also increase percolation to the wells near.

Good examples of these submerged weirs were inspected at Burda, Namano, and Karjano near Silor in the South West portion of the State, and this system might be extended with advantage all over the State as Rock crossings to the Rivers abound where weirs could cheaply be built.

TANKS.—Of Tanks there are said to be 103, but of these the only large ones are (1) the Jait Sagar and (2) Naulakha at Bundi itself, which form the water supply of the city and are not used for irrigation; (3) the Phulsagar, about 3 miles North of the city, on the bund of which is a small Palace, a favourite Residence of H.H. the Maharaja.

A portion of the bed of this Tank is cultivated, but beyond irrigating the gardens round the Palace no use is made of the water of this lake.

(4) The Hindoli Lake, formed by a bund between low hills, on which an old Palace stands, is one of the most picturesque places in Rajputana. It was built about 400 years ago. The water spreads back amongst the hills for about 1 square mile; the Nullah has here a catchment of about 18 square miles, and the Lake a capacity of about 90m. cft.

All the culturable land for 1 mile below, up to the hill by Aklor, is irrigated from the Lake, and cultivation is also carried out on the margin of the bed as the water recedes.

In the Famine this Lake never quite dried up, and was of great protective value.

(5) The Dugari Lake is the largest in Bundi, with a catchment of 35 square miles and a capacity of about 160m. cft. It was built in S. 1151 or 400 years ago.

It is also most picturesquely situated amongst hills, and the artificial bund forming the lake is comparatively short in length. It is a very old Dam; but the lake and village belong to a Jagirdar, so bring no direct Revenue to the State. About 1500 Bighas of land below the Dam are irrigated from the Lake down to Barsi village.

(6) At Nainwa there are 2 Tanks, said to have been built in the time of Akbar, which are used for irrigation.

(7) Also 2 miles East of Nainwa at Khanpur there is a good Irrigation tank.

(8) At Pagara (Jagir) in the North west corner of the State, a Masonry weir has been built across a gorge in the hills, which has all silted up above to within a few feet of the top of the weir.

The bed for $\frac{1}{2}$ a mile back produces excellent Rabi Crops by this saturation, and above that again for 1 mile land is irrigated from wells.

(9) At Dehi a tank was constructed for Irrigation about 30 years ago but is now lying breached (see para 31 (d)).

The remaining 90 odd tanks are only village tanks, useful for drinking purposes, and many of these are said to be breached and out of repair.

Wells. 11. Of wells there are said to be nearly 10,000 in the State, the majority of which are "kutcha," and practically all the irrigation at present is from wells. The average cost of a pucca well is stated to be Rs. 400 ; the average depth of water 40 ft. below surface, and about 5 Bighas are irrigated from each well (1 charas) on an average.

Future possibilities for Irrigation Works.

12. It was noted above that only $\frac{1}{4}$ th of the whole cultivated area in the State is irrigated, the remainder, consisting of black soil (Mal), producing in normal years of rainfall excellent crops without any labour and trouble, probably more than is sufficient for the requirements of the population.

It is probably for this reason that nothing has been done to develop Irrigation, as it has not been considered worth while to investigate for Irrigation works, nor to expend money on improving the crop production, and to protect the State against Famine by the construction of Storage Tanks and Irrigation works.

If the people could be taught to be provident and to save in good years to enable them to tide over a year of scarcity, it would doubtless be unnecessary to think of protective works with soil of this description.

But the figures of the census show how terrible was the loss of life in the State during the last Famine, and how unprotected the State is when such a calamity occurs.

And yet the State is admirably situated, as will be shown later, for the construction of large Irrigation works ; in fact the greater part of the culturable land can be commanded.

The water is there, and sites for impounding it ; extra cultivators are wanted, but if grants of land were given on easy terms at first, these, no doubt, could be obtained.

"Mal" land which is manured and irrigated produces from 3 to 4 times the crop on similar land unirrigated ; looking ahead, when in a few years Bundi will be connected by rail with Bombay, Karachi, and Delhi, there would appear to be a great future for the State with its large wheat and cotton producing area, if the water which at present runs to waste is stored and made use of for its benefit.

In addition to the protection afforded by the construction of these works, the Revenue of the State would be very largely increased, and if the State

cannot provide the funds required at present, it is worth considering whether it would not be wise to obtain money on loan for their construction.

13. Amongst the projects noted as worth Investigation, in the Report laid before the Indian Irrigation Commission, were :—

(a) The construction of a Dam across the Khatkar Gorge where the Mej emerges from the Aravallis passing through Rocky hills, about 500 ft. apart. (Site A, see Index Map).

(b) The Chambal Canal Project from Gamuch 6 miles below Kotah city. (Site B).

14. The Mej river has an unintercepted catchment of 800 S. miles at the Khatkar Gorge so that we can calculate on being able to Store 4010m. cft., allowing 10 per cent. of the rain fall as available.

Khatkar
Project.

From surveys taken it was found that a Dam 90 ft. in height would be required to irrigate the land below, and even then only the top 10 ft. could have been used, as the river runs between very high banks, and at this height, from contours taken, the water spread in the lake formed would be nearly 14 S. miles, and the capacity nearly 11750m. cft., so that there is no possibility of the lake filling to the level required.

The Dam across the Gorge would have to be of masonry forming a weir, as there is no other gap in the hill for an escape: and this height would make the proposal impossible.

Nor could any site for head works of a canal be found lower down, to which the water stored at Khatkar could be let down—a smaller lake and lower Dam being constructed at Khatkar—as the river continues to flow in very deep banks and the country on either side is here full of Ravines, and most unsuitable for our requirements.

It might have been possible to make a Storage Reservoir at the entrance to the Gorge on the other side of the hills, above Rangurh Palace, but the Irrigation channels would have to contour round the hills for nearly 10 miles before they could be brought into use, and the cost of such an arrangement would be prohibitive. The Consulting Engineer inspected the Khatkar Gorge, and decided that nothing could be done here and the proposal should be abandoned.

(See Note by Consulting Engineer for Irrigation—Appendix I.)

15. At Gamach, 6 miles below Kotah city (Site B), there is a good Rock crossing to the River Chambal, suitable for the construction of a weir, and it was hoped that water could be held up here and be taken away on the left Bank by a canal past Patan on to the water shed between the Chambal and the Mej, to irrigate the great area of wheat land, 32 miles in length, lying between. From levels taken, the fall of the River between Kotah and Gamach is only 3 ft., and if the water at Kotah was raised 10 ft. the maximum possible,—and I understand there is a proposal for carrying this out when the Railway Bridge is constructed across the Chambal between

Chamba
Canal Proj

Kotali and Gamach—the weir can only be 13 ft. above the bed of River at Gamach, and the canal bed, which would be say 4 ft. below top of weir, would start in 52 ft. of cutting.

From levels taken, the fall of the country along the line of the canal averages only 3 ft. per mile, and consequently in the 32 miles in which the canal would run in the Bundi State, supposing the canal to have a fall of only 1 ft. per mile, we should not reach the surface for 26 miles, which would be of no use.

It might be possible to take a supply cut starting at a higher level simply to take off a portion of the flood water of the River, and store it elsewhere, without constructing a weir across the River at all, but this would be uncertain, and the cost would be very great.

The Gamach site is the only possible one for the Head works, as above Kotah the nature of the country, which is a high plateau consisting of Rock, would prevent any canal being cut. The idea must consequently be given up, as not feasible. The Consulting Engineer who inspected the River at Gamach and also above Kotah agrees in this.

(See Note by Consulting Engineer for Irrigation—Appendix II.)

Method proposed for
irrigation
in Bundi.

16. The method of dealing with Bundi for Irrigation is however comparatively simple.

In the Southern portion of the State a number of Nullahs, all rising in the hills to the west, pass along in an easterly direction through the Sandstone plateau till they combine near its edge to form the Tai, Ghora-Pichar, and Sukli Nullahs, which then cut their way through the alluvial soil of the plains in deep banks, with tortuous courses and small ravines on either side, until they too unite to form the Kural, which eventually joins the Mej.

What is required is to find sites for damming these rivers at the edge of the Sandstone plateau, while they are under control, where the catchment is suitable for a large percentage of run off, and where the rich culturable land of the plains below is commanded.

Burda Project on Tai
River.

17. Starting on the South West of the State the first site for carrying out this proposal is at Burda (Site No. 1.)

Seven Nullahs with their tributaries have united to form 2 streams, and these two have joined about $\frac{1}{4}$ of a mile above the Site selected for the Dam, at which point the Tai River has cut its way through the Sandstone forming the bed, and is about 700 ft. across from bank to bank, and 30 ft. deep.

This was one of the Projects suggested to the Irrigation Commission as worth investigation; and detailed Estimates were prepared and plans partly worked out, but pending its inspection by the Consulting Engineer the Estimate and completion of the plans was deferred.

The Consulting Engineer inspected the site on the 15th February, 1904, and approved of the Project, which will now therefore be completed. The line for the Dam, which was originally taken straight across the River, was



changed to follow the line of good sound rock throughout, giving a greater length, which is valuable, as the Dam will be of masonry throughout, forming a weir. The Dam will now be in the form of an Arch.

The catchment area is 124 square miles, consisting of rock, or about a foot of earth covering rock, with a good fall to the basin of the Tank, so that a good percentage of run off, quite 15 per cent., may be anticipated.

With this we may estimate on 942m. cft. of water as available for Irrigation.

The top of the Dam, which will be a weir, will be made 30 feet above the River bed, and will be 1500 ft. in length, sufficient to pass the maximum discharge on the catchment of 30525 cft. per second with $4\frac{1}{2}$ feet depth. This flood water will spill over on either side the weir, as there is good rock, and find its way back into the river, which has a rapid fall of 25 ft. down to the plain to be irrigated, a mile away. The sluices will be made on each side where about 10 ft. of rock cutting has to be carried out to make the bed level of sluice the same as that of the River bed, and the banks will be cut away in front.

On the down stream side to form the Irrigation channel a masonry retaining wall will be built on the rocky slope with a gradient of 2 ft. per mile for the first 2 miles, and after that falls will have to be provided, as the gradient becomes steeper, till the plains are reached.

The irrigation will be chiefly on the Right bank and the channel has been set out and surveyed accurately as far as Katorda village, a distance of 4 miles; from here flying levels have been taken, and the canal will pass along the water-shed by the villages of Pitampura, Bobatpura, Deit, and Gurli (See Index Map) and can be extended if necessary towards Anetha if there is water available. On the Left bank the channel has been set out with a fall of 2 ft. per mile for the first mile and then with a steeper gradient till the plains near Ghagos are reached, and from here it can be extended to Chitapura and down the water shed to Lilera.

The objections to the project are that

- (a) It will submerge the village of Burda and ~~314~~ 314 Acres of cultivated land with 20 wells.
- (b) Also ~~88~~ 88 Acres and 10 wells of the village of Murari; and this village too will be on the edge of the flood water and will have to be removed.
- (c) The land to be irrigated is "mal" land, and as noted above produces sufficient crops for present requirements in normal years without Irrigation.

The advantages of the Scheme are :--

- (a) Protection against Famine.
- (b) The water stored will be sufficient to irrigate 9500 Acres, nearly 12 square miles, which area should produce nearly four times the quantity it produces at present, or about 12 maunds more per acre.

If you allow Rs. 5 per Acre, supposing all the land for which there is water is irrigated, an Annual Revenue of Rs. 47,500. should be realized or 27 per cent on the approximate Estimated cost. **Rs 1,75,000 which includes compensation for villages and land & salary**
(See Note by Consulting Engineer for Irrigation--Appendix III.)

Haripura
Project on
Ghora-Pichar
Nullah.

18. The next River, the Ghora Pichar, it is proposed to bund between the Haripura and Kesarpura villages (Site No. 2.)

All the tributary Nullahs have joined just above the site selected, where there is a natural ridge of high ground 3 miles in length running across from the hills on the right to those on the left, and the River has cut its way through the Ridge in deep banks, 185 ft. in width, a hole having been scoured out, the bottom being 30 ft. below the top of the banks.

The Dam would start from the hills on the right bank, crossing a tributary Nullah,—across which the weir would be constructed—to Kesarpura village, then crossing the River to Haripura the Dam would follow the Ridge until the Rocky Hills west of Laen are reached.

The Dam would be 3 miles in length, but except for the portion across the River, would be only 10 ft. in height, as the Ridge forms a natural bund.

The Consulting Engineer approved of the site, and in accordance with his advice the Dam will be entirely of earthwork, the portion across the River being about 20 ft. in width at top, with front slopes 4 to 1 and rear slope 3 to 1. The catchment area is hard to define as two of the large nullahs divide and flow partly into the Ghora-Pichar Nullah catchment and partly into that of the Sukli River. There are 44 miles of catchment, the water of which will all pass to the site, and 92 miles of which a portion, say $\frac{1}{3}$, will be received; but it will be possible to construct weirs with sluices at the dividing points and divert practically all this water, or as much as is required, into the proposed Tank. If we assume that $\frac{1}{3}$ of the water of this 92 S. miles will in any case pass to Haripura, allowing 15 per cent. of the average Rainfall as available we shall have 760m. cft. of water to store.

It is proposed to make the weir level 45 ft. above River bed at the site, viz., about the level of the ridge on which the bund will be formed, and the top of the Dam will be 10 ft. above this. At this level the Tank will have a capacity of about 350m. cft., so should easily fill. The weir will be 850 ft. long, to discharge the maximum flood with a 5 ft. head. This allows for the whole catchment area of 44 + 92 miles.

The high sluice will be made at the lowest part of the ridge on the East of Haripura, with bed level at R.L. 190, and there will be about 1 mile of cutting before the Irrigation channel reaches the surface, after which all the land below as far as Baorikhera village can be irrigated, or about 2 square miles will be commanded.

The low sluice will have its bed level at R.L. 180 and will be built to the East of Haripura, between that village and the River, and the water will pass by a cut into the River itself from which it will flow down to the existing Weir at Namano. This Weir will be raised, the crest being made

up to R. L. 180, and the Irrigation channel will be taken from it off on to the Left bank, starting with bed level R. L. 177, till it joins the canal which started from the high level sluice, near Baorikhera, and this will then be extended on the watershed, between the Ghora-Pichar and Sukli Nullahs, by Godagal village as far as required (See Index map).

The Tank will hold ~~350~~ **300** m. cft., but below R. L. 180 the water cannot be used for Irrigation, so ~~300~~ **300** m. cft. will be available, sufficient for **3000** acres. If the whole of this is taken up, the project should yield a Revenue of **15,000** per annum, at 5 per acre, or **10³/₄** per cent^y profit on the cost, estimated approximately at Rs. **1,40,000**.

(See Note by the Consulting Engineer for Irrigation—Appendix IV.)

19. On the Sukli River, a good site was found about 1 mile below Moriari for a Storage Reservoir (Site No. 3.) The Right bank is high and steep, the ground rising rapidly to 60 ft. above the River bed, but the Left bank is a long slope of Rock on which the weir would be constructed.

Sukli River
Site at
Moriari.

The site does not permit of Irrigation channels being constructed direct from the Dam, and it was first proposed to let the water down the River to Mandaora, a village $2\frac{1}{2}$ miles below the site, where the River leaves the hills and where there is an excellent natural Rock crossing for a weir.

Unfortunately the land on the right bank is too high to be commanded at this point, and is also limited in area: and on the left there are several large Nullahs to cross, which prevent the idea of Irrigation on that bank, until Silor is passed.

From levels taken it has been found that if we let down the water it is proposed to store at the site selected below Moriari, to the existing weir at Karjano, near Silor, some 6 miles below, we can take a canal from here on the left bank, to run along by the villages of Naigaon, Dolara, Khera, and Kishanpura (See Index Map), and can command quite 9 square miles of land.

Time has not allowed this project to be worked out in detail, but it is recorded here so that it may not be lost sight of.

(See Note by the Consulting Engineer for Irrigation—Appendix V.)

20. In the Northern half of the State the system to be followed is much the same, only the line between the hill and plain portion is not so defined and continuous.

Gudha Pro-
ject on Mej
River.

Continuing from the South west, the first River to deal with is the Mej.

A site for a Storage Reservoir has been found near Gudha (Site No. 4.)

The Dam would start on the left bank, from the Hill by Thola village, crossing the River where it is **260** ft. wide and where there is a good Rock crossing,—which extends for some distance down the River—and pass on the Right bank to the hill, to the East of which is the village of Turkeri. The weir would be in the Rocky ridge connecting this hill with the Gudha hill.

They are about 1200 ft. apart. The River has here a catchment area of 290 square miles, all hills, so that we can safely calculate on 15 per cent. of the average rainfall being stored in normal years, or 3300m. cft.

The land to be irrigated is that lying between the Right bank of the Mej and the Bhukea Nullah and the Irrigation canal can be extended down the watershed between these for a distance of about 15 miles to their junction by Olaspura village a mile East of Dablana. At the maximum, not more than 15 square miles will be irrigated. As the land is mostly "mal" and as there are a number of wells existing near the villages passed, perhaps not half this ~~the~~ area will take water.

At any rate if we make our tank with a capacity of 1000m. cft. sufficient to irrigate 10,000 Acres, we shall have enough and to spare. For this the weir level will have to be ^{approximately} 10 ft. above bed of River, and the crest of Dam will be 10 ft. above this again.

The earth is unsuitable for Dam construction, being a mixture of gravel and light soil, so a core wall will be required for the whole length of the Dam, which will be $1\frac{1}{2}$ miles long.

The weir will be 1120 rft. and will pass the maximum discharge on the catchment with a depth of 6 ft.

The Project will be an expensive one, but if 10,000 Acres are irrigated, a yearly Revenue of Rs. 50,000 should be realized, which allows a profit of 10 per cent. even if the cost reaches Rs. 5,00,000.

Surveys are in progress and the project will be worked out in detail.

Bundi-ka-Gotra Project
on Bajaen
River.

21. The next large River to be dealt with is the Bajaen. This River rises in Mewar just beyond the N. W. border of Bundi, and flows for 13 miles in a N. E. direction through the Bundi State, when it becomes for $2\frac{1}{2}$ miles the border dividing Bundi and Jaipur, and then for $3\frac{1}{2}$ miles passes into Jaipur, re-entering Bundi just above the village of Bundi-ka-Gotra. A mile below its re-entry into the Bundi State, the river flows between a high hill on the Right bank and a ridge of low hills on the Left, and by closing this gap a large Storage Reservoir could be formed (Site No. 5.)

The project was suggested to the Irrigation Commission as worth further Investigation, and Surveys were prepared, and it was originally proposed to make the weir level 47 ft. above the River bed, which would give a capacity of 680m. cft. This allows for just over 10 per cent. of the average rainfall on the hilly catchment Area of 134 square miles being stored. Jaipur, however, object to the weir level being made higher than 40 ft. above the River bed, as some 1300 bighas of well land, with about 50 wells in that State would be submerged; and say that they are prepared to make use of the water which passes through the 50 square miles of catchment of the Bajaen in the Jaipur State, by the construction of various small tanks on the tributaries.

Even with the weir at this level, some 600 Bighas of Jaipur land will be submerged, but these are on the banks of the Bajaen and are not at present cultivated, and they have no objection to the construction of the tank, with

this reduced weir level, provided the Bundi State guarantee that cultivation from the water of the Tank may be freely done by "Odis" within the Jaipur State by the Jaipur Zamindars; and that the boundaries of the 2 States remain unaltered.

The capacity of the Tank will be now **347** m. cft; and the Dam will be **7800** ft. in length, with a masonry face wall backed with earth, crest of Dam being 8 ft. above the weir, which will be on the Right bank on the Rocky hill side.

If Bundi construct the Tank they should give the guarantee asked for by Jaipur on the condition that Jaipur too guarantees to make no obstruction to the free passage of water on the main channel of the Bajaan itself within the Jaipur State.

22. To avoid any chance of future dispute with Jaipur, another site was looked for on this River and found 4 miles lower down at Pipalwasa (site No. 6), about 2 miles below Sarshod and Loaria, at which villages the Garjani and Jhonpri Nullahs join the Bajaan on the Right and Left banks respectively.

Pipalwas.
Project of
Bajaan Riv

This site has the advantage of securing the additional catchment of 55 square miles of these two large tributaries; slightly in excess of that within the Jaipur State, which they propose to intercept. It is proposed to take the Dam from the high ground west of Pipalwasa on the Right bank of the River to the mound on which that village formerly stood—since the Famine it is deserted—across the River where there is a good rock crossing, the rock extending away for 500 rft. on the Left bank, to a small hill, and from this on to the high ridge south of Nawagaon village.

The site is an excellent one, but it is found from levels taken that the weir level cannot be made more than **25 ft.** above the River bed, and must then be made long enough to discharge the maximum flood with a 5 ft. head, otherwise the rich village of Loaria and its lands will be submerged. Even with this level, the small village of Nawagaon, with its land, will be submerged.

The Dam will be about **7600** ft. long and will have a corewall throughout; the weir, which will be **750** rft in length, will be partly on the Rocky sloping Left bank of the River itself, and partly at the west end of the Dam beyond the Pipalwasa hill, where there is a rocky ridge. All the Irrigation will be on the Left bank of the River, and starting at R. L. 210 the Irrigation channel will be in cutting for one mile and will then pass down the water-shed between the Left bank of the Bajaan and the Resindo Nullah, past the East of Ranipura and on towards Nimod, and can also be taken across by Sawantgurh on to the next water-shed, between Gajarkhera and Banero.—(See Index Map).

This is all beautiful land, a large portion of which is lying uncultivated for want of water. About 9 square miles of land is commanded or 5760 Acres, of which perhaps 2500 Acres will take water.

As the tank at the weir level proposed will have a capacity of ^{only} **75** m. c. ft. above sluice level, it may later on, if all the land estimated is taken up, be worth while to carry out the Bundi-ka-Gotra Project as a Feeder supply to this.

The upper Tank would irrigate any land below requiring water belonging to the villages of Bundi-ka-Gotra, Loaria and Sarshod, and as this is mostly irrigated already from wells, very little water would be used in this way, and the rest of the water stored would be let down to the Pipalwasa Storage Reservoir and used for Irrigation from that, as required.

The Consulting Engineer has inspected both sites and approved of them and Surveys are being made and the combined project will be worked out in detail.

(See Note by Consulting Engineer for Irrigation—Appendix VI.)

**Pai Balapura
Project.**

23. West of the Bajaan the Dugari Lake stores the water of the next big tributary of the Mej, but beyond that again there is a good site for a Storage Reservoir, the Dam starting from the village of Pai on the West across to Balapura (deserted) on the East (site No. 7). A number of Nullahs join above the site selected, and the tank will have a catchment of 40 square miles, and 200m. cft. of water should be available for storage, allowing 10 per cent. of the average Rainfall as available.

The basin is a good one, and consists of grass land, and no cultivated land will be submerged.

The Dam will be 8800 ft. in length with a core wall starting at the at the East end from the Balipura Hill on the left bank, where the ground is rocky, to a point 2000 ft. beyond the Right bank of the Nullah; the remainder being of earthwork; and the weir, which will be 720 ft. long, and discharge the maximum flood with a 3 ft. head, will be on the rocky Ridge, North East of Balapura, and the water will spill over this on to the land below.

The Irrigation channels will pass, one on to the West by Mana and Dodi to Kalamal, the other on to the East water-shed through the lands of Banjeri down to Jugmunda. These need not be made at once, but can be extended as Irrigation develops.

The work will cost approximately Rs. 83,000, and if all the land for which there is water—1900 Acres—is taken up, it should yield an annual Revenue of Rs. 9,500 or a profit of nearly 11½ per cent. on the outlay.

This was one of the Projects suggested to the Irrigation Commission as worth further investigation; it has been inspected by the Consulting Engineer and was approved by him, and the Surveys are now completed and the plans and Estimate will be worked out in detail.

(See Note by Consulting Engineer for Irrigation—Appendix VII.)

**Small
Projects.**

24. In addition to the 7 large Projects noted on above, a number of smaller ones have been inspected and are recommended for execution. If the Durbar does not feel disposed to start them at once, at any rate they would be useful as Relief works, should Famine occur again, and should not be lost sight of.

They are all in the Northern portion of the State; and three of them are close together near the village of Dhaora, where the Nullahs leave the

hills; and it is only proposed to do what has already been done at the next village, Bhawanipura, where a very useful little tank was constructed 30 years ago.

25. The first site selected is between Neth (deserted) village and Dhaora (Site No. 8). The Nullah has here a hilly catchment of **8** square miles, and the Dam would start from the high ground on which Neth used to stand, across to a hillock on the left bank of the Nullah, a distance of 2050 ft. where it would connect with an old Tank, the dam of which has been lying breached for years. The main earthen bund of the old Tank, 1300 ft. in length, runs eastward, connecting the hillock where the new Dam will end with the high ridge behind Dhaora. The old Dam would have to be repaired. The new Dam will have a corewall throughout, and there is rock close to the surface for foundations. The crest of the Dam will be 22 ft. above the Nullah bed, and 5 ft. above the weir which will be on the rocky-ridge by Neth, the over flow passing into a small Nullah and thence back to the Main Nullah. The Tank will have a capacity of 68m. cft., which allows for a little over 15 per cent. of the average Rainfall on the catchment being stored. *Estimated Cost Rs 21,000. If 600 irrigated Rs 3000 annual Revenue should be realized.*

There is plenty of good land below, and the water from this Tank, and the other two proposed west of Dhaora, can be used for Irrigation down to Dablana, 3 miles away, if necessary.

Neth Proj

26. The next site is where the small Nullah close to and East of Dhaora passes through the hills (Site No. 9). The catchment is **2** square miles only, and the Dam will be **1500** ft. long, with a corewall and front and rear slopes of earth, the top, **17** ft. above the Nullah bed, and 5 ft. above the weir which will be on the west near Dhaora. The Tank will have a capacity of **20** m. cft., viz., **20** per cent. of rainfall on the catchment, and **150** Acres could be irrigated, yielding an Annual Revenue of Rs. 750 at Rs. 5 per acre or **5½** per cent. on the approximate estimated cost, **Rs 13500**

Sites to Tanks a Dhaora

27. Continuing East towards Bhawanipura, there is one more Nullah of which no use is made at present (Site No. 10.)

The Dam will be **3000** ft. in length connecting the low ridges through which the Nullah flows, and **24** ft. above the Nullah bed. A corewall will be necessary, with front and rear slopes of earth. The weir will be on the rocky ridge on the left bank, and **19** ft. above the Nullah, at which level the Tank would have a capacity of **39** m. cft. *or 15 per cent. of rainfall* on the **5½** s. miles of catchment. It will cost approximately **Rs 31500** to construct, and *should* yield a Revenue of Rs. 1900 at Rs. 5 per acre, *or a profit of 6 per cent.*

28. Further East again, close to the East end of the proposed Pipal-wasa Dam on the Bajaen, is the village of Takro.

Site for T at Takro

Below the village is an old breached bund, and the village complains of great scarcity of water in the wells.

Instead of repairing the old Dam, there is, I think, a better site (Site No. 11) just above the village, the Dam passing straight from the high ground on which the village stands across to the low hill on the E. of the

Nullah. With a Dam here, only about 5 wells would be submerged, instead of 12 at the original site, and the land in the bed of the old tank would also be commanded.

The Dam would be about ~~1350~~ 1350 ft. long, of earthwork with corewall, top 20 ft. above Nullah bed, and 5 ft. above the weir, which would be built across a gap 200 ft. in length in the ridge extending from Tokra village at right angles to the line of Dam. The Tank would have a capacity of 13 m. cft. or 12 per cent. of rainfall on 2 square miles of catchment.

The approximate cost is Rs. 9500 and an annual Revenue of Rs. 625 should be realized or $6\frac{1}{2}$ per cent profit.

29. The above four projects will be surveyed and Estimates and plans worked out in detail, but the following sites were also selected, and as time did not permit of their being surveyed they are brought to the notice of the Durbar as worth investigation, and execution.

Sites for
Tanks at
Gamera.

(a) At Gamera on the N. E. corner of the State, three Nullahs unite, one from Arnea, the second from Shandila, and a small one from Manpura (Sites Nos. 12 and 13).

The village is surrounded by fields irrigated by wells, but there is plenty of land above lying idle, and if the first two Nullahs were dammed about a mile above the village this land and the beds of the Tanks themselves could all be cultivated, and the wells below would be benefited. There are 2 small tanks close to the village and the Manpura Nullah flows between them. These should be connected, and the water of the Manpura Nullah thus stored.

The land is all "mal" lying on the top of mooram, and the latter is found in all the Nullah beds, a corewall would therefore be necessary in all the Dams constructed.

Site at
Samedli.

(b) At Samedli the Nullah should be stopped above the village (Site No. 14) and all the land would come under cultivation and the land below be irrigated and wells improved. The soil here is similar to that at Gamera.

Nullahs
flowing
across N. E.
border.

30. On the East border between Samedli and Karwan there are 4 Nullahs which flow in an Eastern direction into the Alligurh Purgunnah of the the Tonk State.

With these nothing appeared possible, except the construction of weirs to hold up water near the villages, as the land by the first three is principally rocky and unculturable, until near Karwan, where the rich "mal" soil begins again, and continues all along to the west, parallel to the central range of Hills. This mal is a few feet in depth, lying on the top of mooram and gravel, and by the Nullahs the land gets broken and cut away and nothing but the mooram strata is visible. On the "mal" itself large areas of wheat and barley are grown without irrigation.

Sites at
KhaJuria,
KhaJuri,
Bansoli, and
Tank at
Dehl.

31. Turning westward from Kharwan there is one main Nullah running parallel to the central range of hills, which eventually joins the Mej on the left bank just as it enters these hills by Gudha.

This Nullah is joined by a number of tributaries on the North, on each of which sites were selected for possible Irrigation tanks.

- (a) At Khajuria (Site No. 15) a small tank could be formed above the village which complained of scarcity of water in their wells.
- (b) At Khajuri (Site No. 16) there is a very good site below the village. The Dam would start on the right bank below the temple of Brahma, cross the Nullah, and circling round all the broken ground would end by a clump of trees on the left bank. The catchment Area is 15 S. miles. Between the village and the site the land all round the Nullah is broken up and at present unculturable; by forming the Dam as proposed, the bed would all silt up, and as the water receded would be cultivated; and the land belonging to Khajuri on the left bank, and Sen on the right would be commanded.
- (c) Again at Bansoli, above the village, where three Nullahs meet, (Site No. 17) a Dam should be formed to store the water and irrigate the land below. There is a catchment Area of 17 S. miles. The Dam would start at the Temple of Mahadeo on the left bank, cross the Nullah and pass by the well of Alli Bux, Mina, on to some high ground on the right.
- (d) Finally, at Dehi, a Dam was constructed about 20 years ago above the village, on which I was told Rs. 50,000 had been spent. (Site No. 18).

There is a thick facewall for about 1000 ft. in length in the centre, with buttresses; and steps for a Ghat were commenced; the remainder of the Dam, the total length of which is about 3000 ft., is of earthwork; it has breached 2 or 3 times, and is now lying breached in 3 places, two on the east of the face wall and one at the west end.

The earth is unsuitable for an earthen Dam as it consists of black soil, with slate shale, and a corewall throughout should have originally been constructed. If money had not been wasted on useless masonry in the centre, a corewall for the whole length could probably have been constructed for the amount already spent.

The Dam should be repaired without delay, as there is plenty of land below for cultivation, and the bed itself is cultivated as the water recedes.

32. This completes the Investigation. Seven large projects are proposed, and 10 smaller ones, and when they are carried out the greater portion of the culturable land will be commanded.

Great possibilities for
Irrigation in
the State.

Irrigation has so far not been developed and there are great possibilities.

At present an enormous volume of water passes away each year unused, and this water is money lost to the State.

F. ST.-G. MANNERS-SMITH,
SUPERINTENDING ENGINEER,
Protective Irrigation Works, Rajputana.

Ajmer, April, 1904.

Note by the Consulting Engineer for Irrigation in Rajputana.

1. The Superintending Engineer, Mr. Manners Smith, has submitted a Report on Irrigation in the Bundi State which is very interesting and contains much useful information. It shews the interest he takes in the subject and the thorough way in which he carries out his investigation.

The places are clearly indicated on the Topographical map which gives a good idea of the country we have to deal with. It consists of high and rocky ground at the west, the highest part of the State, from which direction all the rivers come ; and they flow, in both the North and South portion of the State, generally in an Easterly direction, but towards, not away from, the central range of hills which divides the State.

The State is admirably suited for irrigation and the greater part of the culturable land can be commanded, and as the Superintending Engineer remarks "looking ahead when in a few years Bundi will be connected with Bombay, Karachi, and Delhi, there would appear to be a great future for the State, with its large wheat and cotton producing area, if the water which at present runs to waste is stored and made use of for its benefit."

2. The problem of how to deal with ~~with~~ such a country is an interesting one. In the Southern half of the State the plan is "to find sites for damming the rivers at the edge of the high sand-stone plateau while they are under control, where the catchment is suitable for a large percentage of run off, and where the rich culturable land of the plains below is commanded."

In the northern half of the State, to look out for sites where there is a good catchment area, with good land below, where the water can be used.

It is of no use to take even a good site high up, if there is no good catchment, nor a good site low down, where there is no land to take the water.

An inspection of the map will shew that the Superintending Engineer has rightly adopted this course. On the Southern half of the State the storage reservoirs are high up, near the plateau on the west; on the Northern half, the sites are more or less central.

3. The sites inspected by the Consulting Engineer were :—

- (1) The Khatkar gorge.
- (2) R. Chambal.
- (3) Burda Storage Project.
- (4) Haripura Storage Project.
- (5) Moriari Storage Project.
- (6) Pipalwasa Storage Project.
- (7) Bundi-ka-Gotra Storage Project.
- (8) Pai Balapura Storage Project.

His remarks on each will be found in the appendix.

The description of these places is given so fully by the Superintending Engineer that the Consulting Engineer has merely recorded his opinion.

It must be remembered the time has been short, and as many of these places are difficult to reach the work done speaks for itself.

4. Irrigation has not been developed in the Bundi State, and though fortunately Famines seldom occur, yet during the recent famine the State lost about 42 per cent. of its population, and there is an immense quantity of water which every year goes to waste.

Wherever water has been stored judiciously the benefits are apparent: for instance at Dugari, Hindoli, Bhowanipura.

Scanty population will no doubt limit irrigation, but in time this ought to improve; and to provide water is the best way to secure this result.

The Superintending Engineer's proposal, as explained in his Report (para 22), to carry out the Bundi-ka-Gotra Project as a feeder to a dam at Pipalwasa below it, seems an excellent idea.

5. Before carrying out any of the Projects suggested, it will be advisable to ascertain the opinions of the Revenue Officials. This will be a safe measure and ensure co-operation—there has not been time for us to do this yet, nor to prepare all the Projects in detail.

We can but suggest to the Durbar what appears desirable.—If there is a real desire to take up Irrigation it will be easy now to do so—and these investigations and notes ought to prove of the greatest help. We have had to hunt for the places; now, they are all indicated, and so time and money will be saved.

6. The projects which have been suggested should not be lost sight of. The remarks of the Superintending Engineer in his para 24 are sound.

7. Another feature in the Bundi State is the submerged weir. There are many, built across rivers to hold up a few feet of water. In the rains the floods pass over and afterwards the water which is stored is raised to irrigate lands on both banks and by percolation benefits the adjacent wells and springs below—See the Superintending Engineer's para 10. As he rightly observes this system might be extended with advantage all over the State.

The effect of water stored thus in such a country is wonderful.

8. The question is, do the Durbar really wish to have any of these Projects carried out? It is no use to take up Irrigation in a half hearted sort of way.

If there is a real wish, but financial difficulties prevent anything being done, then no doubt the Political Department will suggest something to help the State and overcome these difficulties.

As Engineer Officers we have done so far all we could; whether any good results will follow remains to be seen.

9. In any case, if it has not been already done, it would be a good plan to have all these Projects properly drawn out and placed on record and indicated at site by permanent bench marks.

10. I cannot conclude this note without acknowledging the courtesy and help we have received from the Bundi Durbar while carrying out these investigations.

S. S. JACOB, COLONEL,
Consulting Engineer for Irrigation in Rajputana.

Jaipur, April, 1904.

APPENDIX I.

Khatkar Gorge.

The river here has a drainage area of about 800 square miles. The site has the following drawbacks :—

- (1) There is rock on each side but none is visible in the bed, which no doubt exists but must be deep, as there is a deep pool of water here.
- (2) There is no good basin for Storage.
- (3) There is a quantity of drift sand in the river banks and higher up, which would cause a great deal of silt to deposit in the reservoir.
- (4) There is no suitable place for an escape.
- (5) The bed of the river is some 30 ft. or more below the general level of the ground and it would be difficult to gain the surface for Irrigation, and the ground is moreover much intersected with ravines.
- (6) There is not enough land below to irrigate or to make it advisable to incur such a heavy outlay as a dam would cost here, even if the site had been otherwise favorable.

I therefore agree with the Superintending Engineer that it is not advisable to go to the expense and trouble of preparing plans and Estimate.

APPENDIX II.

The River Chambal—The Gamach Project.

On the 14th February 1904, I went to Gaouri, a village about 6 miles below Kotah on the River Chambal, to see the site where it was suggested a weir might possibly be put to take the water off on the left bank, near the village of Gamach, to irrigate land in the Bundi State between the Chambal and the River Mej.

To start a canal in 52 ft. cutting with the prospect of not coming out on the surface for 26 miles seems to me prohibitive, nor do I approve of starting at a higher level even if it was possible to take a supply cut away from the river, for the cost would still be great and I doubt if it would pay.

I am not sure if the necessity exists for taking water at all from the Chambal, for the irrigation of this tract of country. It is possible that the Storage Reservoirs which are suggested on the high land further west may be sufficient for many years to come to meet all the requirements in this direction; the rainfall on these rocky hills if it can be stored may be ample; and until the necessity of storing more water than is available arises, I do not think it would be advisable to take up such an expensive project as any canal from the Chambal here, would be.

APPENDIX III.

Burda Project on the Tai River.

Rode to Burda, a Jagir village, reached camp midday, after inspecting site of proposed Storage Reservoir about 1 mile North of Burda.

There is a long pool of water in the bed of this Nullah where it passes the village— the banks are lined with trees, and cultivation is carried on by means of wells on the edge of the river.

The site proposed for the bund is where the river passes through a low range of sand stone hills; 7 tributaries forming 2 main Nullahs unite just above the point and the drainage of 124 square miles all passes through the low range. The catchment area is rocky waste land, excepting close to the villages of Burda; Atias (hamlet,) and Moriari. Burda is the only important village. The basin for storage is magnificent. At the site of the proposed bund there is good hard rock in the bed all the way across, and at the sides. There is any amount of good stone at hand for a masonry dam. Altogether it is an ideal site for a storage reservoir.

The only drawback is the amount of cultivated land which will be submerged round the village of Burda : but if the Bundi Durbar will compensate the Jagirdar by giving him an equally good Jagir elsewhere, or in some other way, this difficulty may no doubt be got over.

I approve of Mr. Manners Smith's proposal to put the bund about 150 ft. higher up than originally fixed, as there is better rock here, and some saving in height, although the length may be a little longer; but as this will afford a little longer escape it will be an advantage.

It only remains to check the surveys which have been already made ; to ascertain the correct line for the canal, and the area commanded and the quantity of water stored ; to revise the plans for the masonry dam and outlets ; to ascertain approximately the cultivated area which will be submerged, and compensation for any wells and property which will be under water; and to prepare the Estimate.

I consider this to be one of the most promising sites for a storage reservoir that could be found.

APPENDIX IV.

Haripura Project.

We went across the west portion of the catchment of the Burda Reservoir Project, passing the village of Kalianpura, where we entered the catchment of the next Nullah. The drainage from this place unites with a large Nullah which passes the village of Laen and unites with it just below the village of Retia.

A few hundred feet below this point, on a line passing from the village of Kisanpura,—a small village on the right, and Haripura on the left (west) bank, the ground is high on both sides and it appears a good place to put an earthen bund across the Nullah. There is any amount of good earth, the drainage of about 50 square miles would be intercepted here. The storage basin is very large and apparently nearly all waste, rocky ground.

The only points to be ascertained are whether a suitable place can be secured for an escape at one or either end of the proposed bund line, on rock, either on the natural surface or in some Nullah bed; and what height the bund can be made? what can be irrigated? and how it can be best made to reach that land? The Superintending Engineer has ordered surveys to be prepared and when these are ready it will be possible to give a definite opinion.

All that can be said at present is that it seems to be a promising project and well worth further investigation.

In the evening inspected an old masonry submerged weir about $\frac{1}{4}$ mile below the village of Namano about 300 ft. long, 10 ft. high, and 10 ft. thick, on rock. It holds up a fine pool of water below the village and extends back for nearly a mile. The banks are shaded with fine trees which present a very pleasing sight. It is more like a river in Kashmir—the water is used from wells on the river bank for cultivation of the ground near. It is a good example of a submerged weir.

Since the above was written the information furnished by the Superintending Engineer shows that there are great possibilities here, and I have no hesitation in recommending this Project.

APPENDIX V.

Moriari Storage Project.

We then entered another catchment, and passed 2 or 3 deserted villages such as Motipura and Moriari. The latter is said to have had 100 houses; only 10 families now remain near it—the village is deserted.

Two Nullahs from the South unite below Moriari, and about $\frac{3}{4}$ mile lower down is a good Site for making the dam of a Storage reservoir.

Drainage of about 110 sq. Miles would be intercepted here, the right banks are about 60 to 70 ft. high, of hard soil—the left side is a sheering bank of hard rock which extends from across the bed of the Stream to the rocky hill on the west. The left bank is well adapted for a natural escape, at any desired height. Stone is plentiful.

Kunker can be had for lime not far away and fuel is obtainable close by.

The difficulty will be to lead the water away to suitable ground for Irrigation—as the country is cut up with deep ravines for some miles.

There is a good ledge of rock across the Nullah about 3 miles lower down, between the villages of Mandaori on the right bank and Garnaro on the left or west bank. If suitable land can be Commanded by a Canal taking off from this or any similar place then it will be advisable to have surveys made and the data approximately obtained, showing what height of dam it will be advisable to make?

As far as the site is concerned for a dam, it appears to be a good one; and until further data are obtained it is impossible to say more at present.

In the evening, hearing there was an old native weir in the river about a mile South of Selor at Karjano, I rode out to see it.

There are two—the upper has been out flanked and is apparently now of no use, but water is held up by another old masonry weir about $1\frac{1}{2}$ miles lower down. It is about 350 ft. long, 12 ft. high, and 10 ft. thick, founded on rock over which the floods pass. It appears to have been out-flanked at the South end more than once and to have been repaired more than once. A good deal of cultivation is done on each side of the Nullah by the open wells at the river banks which are here about 20 ft. or more in height. The river is about 150 ft. wide.

This is another instance of the benefit derived from a submerged weir.

APPENDIX VI.

Pipalwasa Project and Bundi-ka-Gotra Project.

We found a probable site for a large storage reservoir on a line from some high ground south of Nawagaon to Pipalwasa. The latter is a collection of deserted huts on rising ground and apparently would form the westward end of the proposed bund, which would be probably $1\frac{1}{2}$ miles long.

The line crosses the Bjaen Nullah after it has been joined by two other Nullahs, one from the west called the Garjani the other from the North which may be called the Jhonpuri Nullah.

There is a capital rock crossing in the bed of the Nullah and the rock crops out on the left or east side and at other places. There is good earth along other parts of the line for an earthen bund, and apparently unlimited good land beyond which could be irrigated. The basin for storage appears large and good.

The drainage area at this point will be about 180 square miles, much of which is hard rocky ground.

If the small bunds proposed by Mr. Stothered, the Superintending Engineer of Jaipur, to be made near Gotra are carried out at any time they would cut off about 50 Miles—there would still remain the drainage of 130 miles available for storage. There is however the fear that a good deal of cultivated land may be submerged if the Dam is to be of any height. This remains to be seen.

We then inspected the site originally proposed about half a mile above Bundi-ka-Gotra, where the river passes through a low range of rocky ground. The original H.W.L. was taken as R.L. 147, about 47 ft. above the bed of the river. Objection was raised against this H.W.L. as submerging fields and wells belonging to Jaipur, and it was suggested the H.W.L. should be reduced to R.L. 140. The surveys for this project are partly completed.

There may be some difficulty in getting a canal away from this site, especially on the west or right bank, as the ground is rocky for some distance—but until the project is completed it is impossible to say. The drainage area here is about 130 square miles which may some day be cut off by the works proposed by Jaipur.

The ground here is rocky—earth is scarce and a masonry bund, or a bund with a masonry face wall, would be necessary. Rock is not visible in the Nullah crossing, through no doubt it will be found not far below the surface.

Of the 2 sites on this Nullah, as far as I have seen at present, I prefer the Pipalwasa Site, because :—

- (a) The drainage area is 50 miles larger.
- (b) There is better crossing, all solid rock, across the Nullah at the site proposed.
- (c) There is plenty of good earth here.
- (d) The work would be better adapted as a relief work.
- (e) The water could be led off with less difficulty for irrigation.
- (f) It could be raised at any time if necessary without any interference with land in the Jaipur State.

Until Surveys have been prepared, it is impossible to speak with certainty.

I would suggest both these projects being prepared and when all the data are available it will be easier to decide which is the best site or whether it will be advisable to combine and make both.

APPENDIX VII.

Pai Balapura Project.

Inspected the site of the proposed Storage Tank. Balapura is a mound with a few trees on it. Scarcely any trace of a village remains. Rock is near the surface at the mound and on both sides East and West of it; rock is also met with in the Nullah it is proposed to bund. The soil everywhere is good dhamni, a corewall would only be necessary across the Nullah and where rock crops up, or is near the surface. The basin for storage is very large and good. The escape might be on either side East and West of the Balapura mound, over the natural rocky surface, or where very little masonry will be required. There is good land below.

The margin of the lake ought to afford a large area for cultivation as the water recedes. This would be well adapted as a Famine Relief work. The line for the bund in the plan originally prepared was taken higher up. The line proposed now takes in another Nullah which will add a little to the catchment and provides a much larger storage basin.

I recommend plans and Estimates being prepared as soon as possible.

